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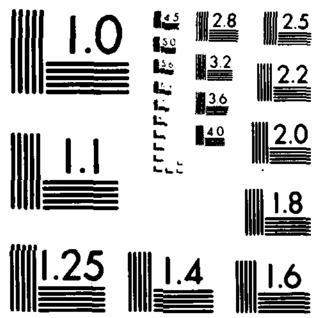

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Report No. FAA-RD-80-123

LEVEL III

12

A SUPPLEMENTARY ELECTROMAGNETIC COMPATIBILITY ANALYSIS OF THE PROPOSED AIRPORT SURFACE DETECTION EQUIPMENT (ASDE) RADAR

AD A092965

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IIT Research Institute
Under Contract to
DEPARTMENT OF DEFENSE
Electromagnetic Compatibility Analysis Center
Annapolis, MD. 21402

August 1980

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16. Abstract

This report supplements information in an earlier report~~, FAA-RD-77-183, published in 1977~~, which identified electromagnetic compatibility (EMC) problems associated with the deployment of Airport Surface Detection Equipment (ASDE-3) Radars at a number of proposed sites in the United States. Subsequent to the earlier study, several operational parameters of the ASDE-3 radar have been modified in a direction to lessen the probability of causing or receiving interference, thereby, necessitating a reanalysis of portions of the earlier study.

As before, interfering signal levels are compared against established receiver thresholds to determine operational compatibility and frequency management techniques are identified as a solution to potential interference cases, where applicable.

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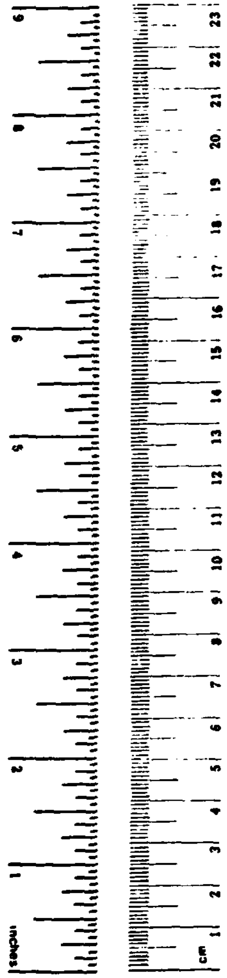
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

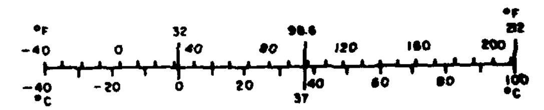
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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SECTION 1
INTRODUCTION

BACKGROUND

The Federal Aviation Administration (FAA) is implementing a new generation of Airport Surface Detection Equipment (ASDE) radar, referred to as the ASDE-3. These systems will provide ground traffic control personnel with a means of identifying and controlling vehicular traffic on airport surfaces during all weather conditions when the airport is operational.

In FY76 the FAA requested that the Electromagnetic Compatibility Analysis Center (ECAC) identify potential electromagnetic compatibility (EMC) problems which may exist with other government systems when the ASDE-3 is deployed at 33 proposed airports in the United States. Information contained in the Government Master File (GMF) was used to identify other government systems in-band. After the original analysis, several characteristics of ASDE-3 were modified. ECAC has been requested to repeat portions of the previous analysis, since the modifications to ASDE-3 are directed toward the reduction of the potential interference cases reported in the previous study.[1] This report supplements the information presented in Reference 1.

OBJECTIVE

The objective of this study is to re-assess potential EMC problems, which were identified by a previous study, based on the latest operating characteristics of the ASDE-3 engineering model.

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[1]Preis, J., Malicka, T., An EMC Analysis of the Proposed ASDE-3 Airport Surface Detection Equipment Radar (U), FAA-RD-77-183, ECAC, Annapolis, MD, December 1977.

Section 1

APPROACH

All of the airborne equipments in the prior study (Reference 1), and those ground-based equipments that the prior study identified as a potential source of EMC problems, were re-examined. This analysis considers measured ASDE-3 emission spectrum data, measured receiver selectivity characteristics, and specifications of transmitter band-pass filtering. In addition, ASDE-3 utilization of the 15.7-16.2 GHz band has been modified by dividing it into two subbands, one at the lower end and one at the upper end. ASDE-3 frequency hopping may be used in either one or both of the subbands, depending on the ASDE-3 site location and the operating frequency of the victim/interferer equipment.

As before, interfering signal levels were compared against established receiver thresholds to determine potential interference problems. Where appropriate, recommendations have been made regarding subband operation and/or frequency management as a possible solution to any potential interference cases which may exist.

SECTION 2
ANALYSIS

ASDE-3 CHARACTERISTICS

The frequency band proposed for the ASDE-3 is 15.7-16.2 GHz.[a] Within this band operation may be restricted to the upper or lower portion if interference to/from other systems is a problem. For the purposes of this analysis, the lower band is referred to as subband 1 (15.77-15.95 GHz) and the upper band as subband 2 (15.95-16.13 GHz). Figure 1 depicts the frequency plan. In the frequency-agile mode, ASDE-3 may use 6 discrete frequencies (with 30 MHz separation) within a given subband, and 1 overlapping frequency, or up to 13 discrete frequencies within the full band.

TABLE 1 is a listing of the modified characteristics of the ASDE-3 system that were provided to ECAC for use in this EMC analysis. These modifications include a 4 dB reduction in antenna mainbeam gain and the inclusion of a 3 dB waveguide insertion loss. In addition, the ASDE-3 transmitter emission power was reduced by approximately 8 dB. Measured data regarding the emission spectrum was supplied and is shown in Figure 2. The receiver IF bandwidth was unchanged. However, detailed selectivity data was provided (see Figure 3). In the original analysis, only the 3 dB IF bandwidth was available and a receiver selectivity curve was estimated. The receiver sensitivity was also modified; the current version is 1 dB less sensitive.

There are 33 airports in the U.S. that have qualified for ASDE-3 radars (see Reference 1). These radars are expected to be installed on top of existing control towers wherever possible, and will utilize a rotodome antenna with the beam directed slightly downward (at a 1° depression angle) to provide ground coverage within a distance of 500 ft to 3 nautical miles (nmi).

---

[a]NTIA National Table of Frequency Allocations, Footnote G59: "In the band... 15.7-17.7 GHz all Government non-military radiolocation shall be secondary to military radiolocation, except in the sub-band 15.7-16.2 GHz. ASDE is permitted on a co-equal basis subject to coordination with the military departments."

TABLE 1

MODIFIED CHARACTERISTICS OF THE ASDE-3

Characteristics		Current Analysis	Prior Analysis
Antenna Gain (dBi)		43	47
Transmitter Emission Characteristics (MHz) (See Figure 2)	3 dB	±14	±18
	60 dB	±150	±600
Receiver Sensitivity (dBm) For S/N = 13 dB		-77[a]	-78
Transmitter Peak Power (kW)		10	60
Additional Losses (dB)		3	0

[a]Measured Data.

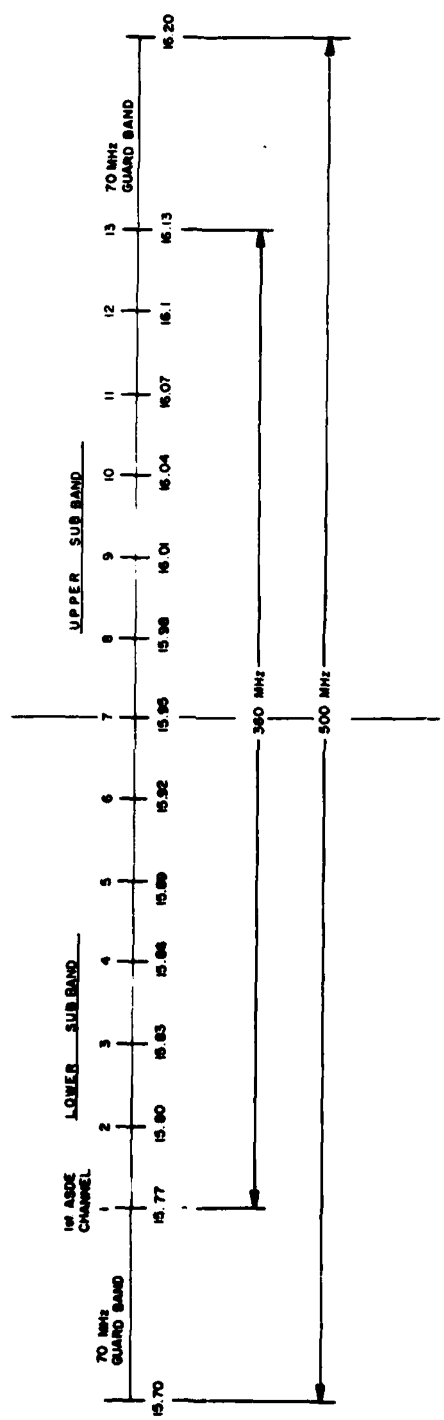
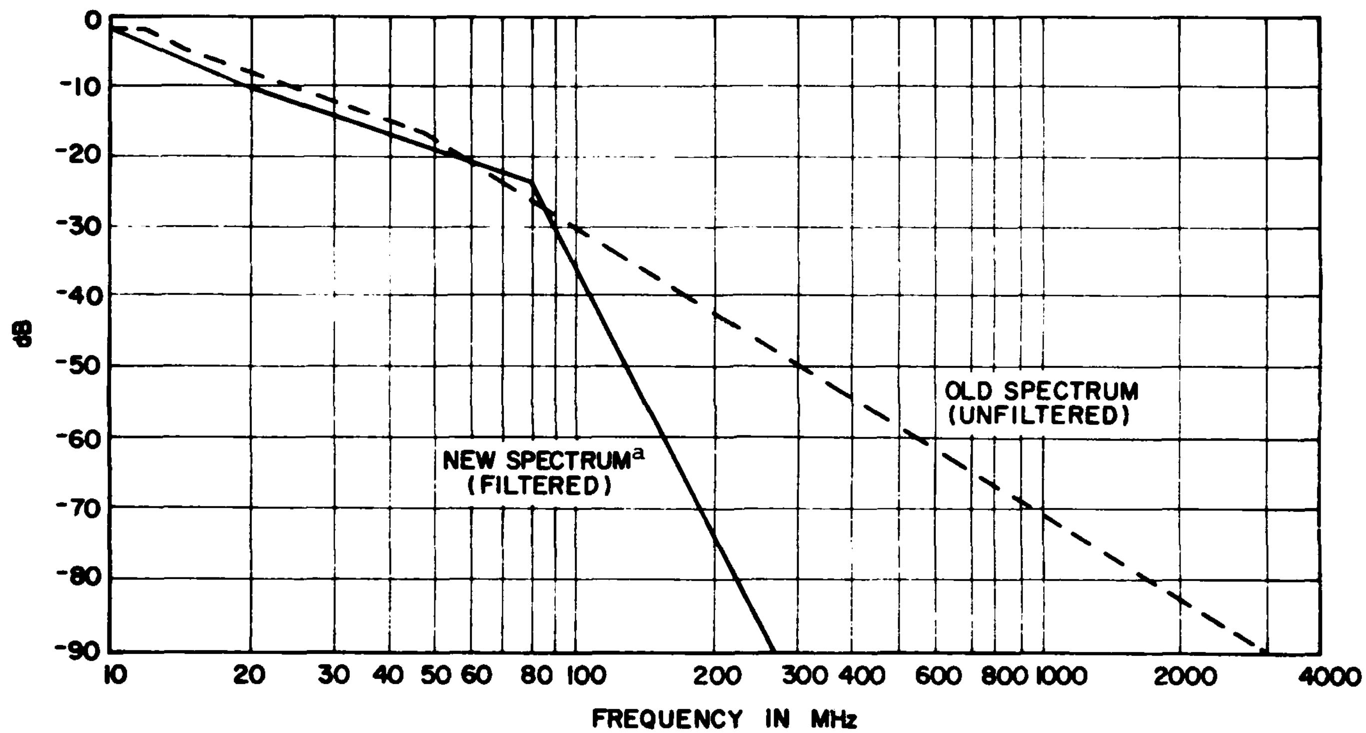
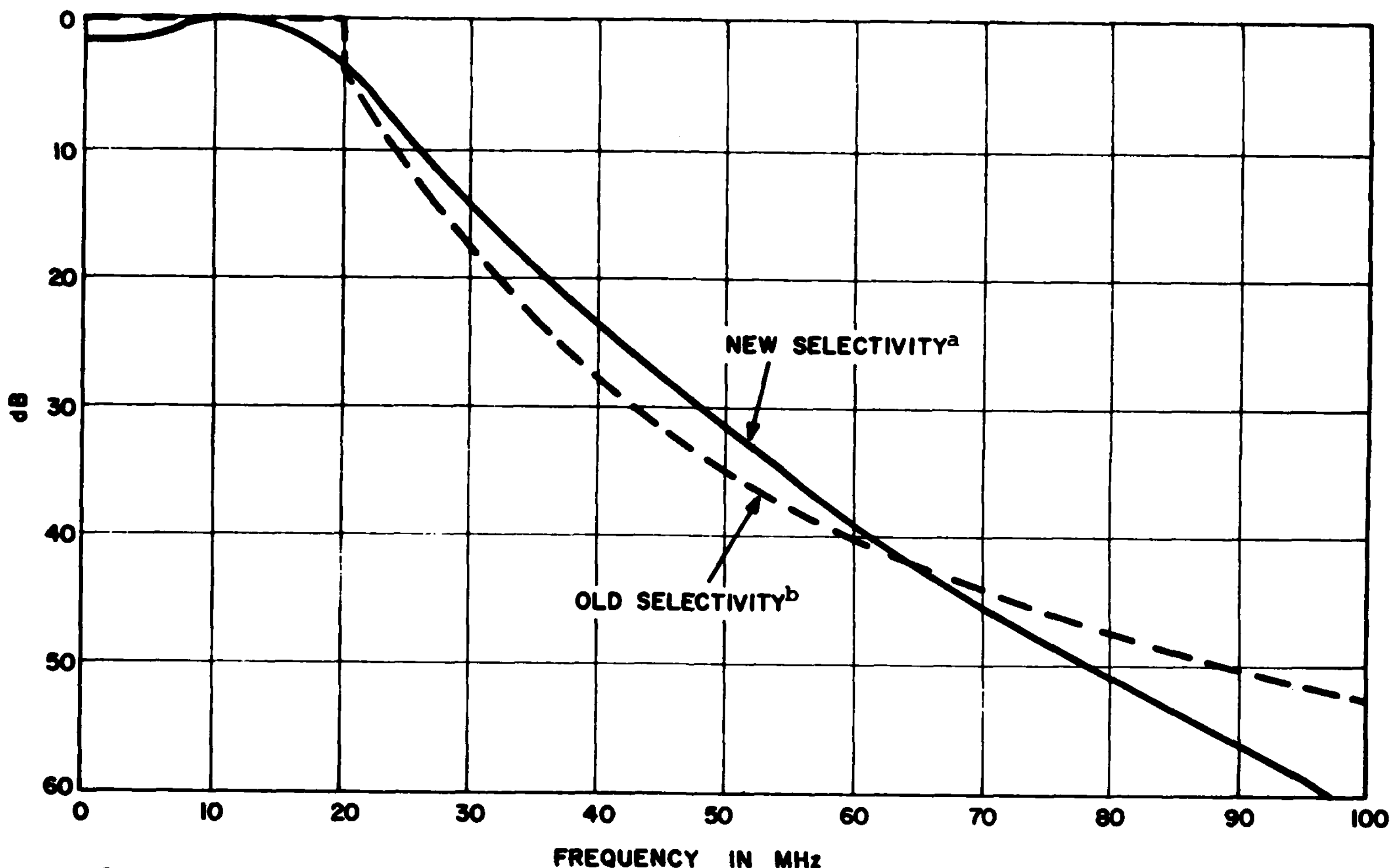


Figure 1. ASDE-3 frequency plan



[a]Conservative engineering model of spectrum provided by the FAA.

Figure 2. ASDE-3 emission spectrum (proposed).



[a]Measured data provided by FAA.

[b]Original estimate assuming a 3-pole filter.

Figure 3. ASDE-3 receiver selectivity curve.

Section 2

ANALYSIS CONSIDERATIONS

Ground-based Systems

Environmental ground-based systems were analyzed again to determine the impact of interference to and from ASDE-3. Of these systems, some operate in the ASDE-3 frequency band or at frequencies adjacent to either side of this band. Since the proposed changes to the ASDE-3 (i.e., power, sensitivity, and antenna gain) would tend to reduce interference, only those system interactions listed in Reference 1 that were predicted to result in interference were re-analyzed. The characteristics of these systems are listed in TABLE 2 and their various frequency bands are shown in Figure 4. Mason-Zimmerman emission bandwidth approximations were used. This method of approximating emission spectra makes use of the transmitter pulse width and the rise/fall time of discrete pulses for pulsed systems. The frequency points f_1 and f_2 respectively determine the start of a 20 db/decade slope that ends at point f_2, at which point a 40 db/decade slope begins. Frequency point f_1 is inversely proportional to the pulsewidth (τ) and frequency point f_2 is inversely proportional to the pulse rise time (δ_r) and pulse fall time (δ_f).

Calculations were performed to determine the potential interference to and from ASDE-3 and the specified systems. The level of interference at the victim receiver was calculated using the same methods as those utilized in Reference 1. The interference threshold for the ASDE-3 receiver was taken to be the receiver sensitivity level, as listed in TABLE 1. System location and associated path losses were the same as those assumed for the prior analysis. These path losses include effects due to terrain shielding.

The antenna gain of environmental equipments was assumed to be equal to 0 dBi, implying the absence of mainbeam-to-mainbeam antenna coupling (see original report for elaboration and justification). ASDE-3 mainbeam gain was used in all cases.

Worst-case peak interference power was calculated assuming that both transmitter and receiver are on-tune. Any off-frequency rejection (OFR) required to achieve electromagnetic compatibility was compared to the OFR available as a result of the difference between the center frequency of the interacting system and the ASDE-3 center frequency at the appropriate subband edge. If that frequency separation was not sufficient, then interference would still be possible. The following formulation for interference power for ground-based equipments was used:

$$P_I = P_T + G_T + G_R - OTR - L_P - L_I$$

where

P_T = Transmitted Power (dBm)
G_T = Transmitting Antenna Mainbeam Gain (dBi)
G_R = Receiving Antenna Gain (dBi)
OTR = On Tune Rejection (dB)
L_P = Path Loss (dB)
L_I = Waveguide Insertion Loss (3 dB).

TABLE 2

TECHNICAL CHARACTERISTICS OF GROUND-BASED EQUIPMENTS

Nomenclature	Frequency (GHz)	Peak Power Output (kW)	Pulse Width τ (μs)	Rise Time δ_r (μs)	Fall Time δ_f (μs)	Emission Spectrum (MHz)	IF Bandwidth (MHz)	Receiver Sensitivity[b] (dBm)
AN/PPS-5	16.0-16.5	1.0	0.25[a]	0.07	0.14	±1.70[a]	5.0	-95
SAD	16.3	35.0	0.5	0.05[a]	0.05[a]	±.90[a]	2.0[a]	-91
108K (VEGA)	15.72-15.73	1.2	0.5	0.5	0.1	±.90[a]	27.0	-65
322K (VEGA)	15.725	1.2	0.5	0.05	0.1	±.83[a]	27.0	-65
AN/MPQ-4	16.0	50.0	0.25	0.025[a]	0.025[a]	±1.70[a]	5.0	-96

[a]Estimated Values

[b]Minimum discernible signal.

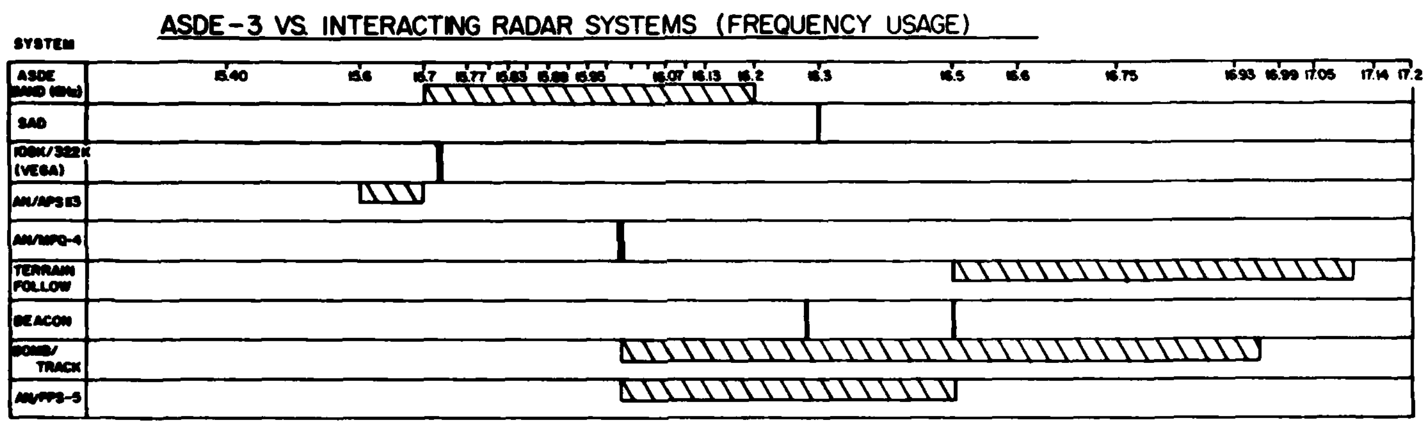


Figure 4. Operating frequency ranges of interacting systems.

Airborne Systems

As indicated in Reference 1, the airborne systems of concern are those associated with U.S. military fixed-wing aircraft of the fighter, fighter-bomber, or tanker class. Because of the similarity in technical characteristics, the systems associated with these aircraft were grouped into four categories as shown in TABLE 3. Also included is an airborne weather radar. Figure 4 displays the airborne frequency bands. Mason-Zimmerman emission spectrum approximations were again used for the weather radar.

Off-frequency rejection and on-tune rejection (OTR) were calculated by computer for each category. With these results, separation distances required for compatible operation were calculated. This was performed for both ASDE-3 subbands utilizing the appropriate subband edges; a sample of this method follows. If ASDE-3 operates in Subband 1, the worst-case frequency separation (Δf) from the AN/APS-113 is 170 MHz. The available frequency dependent rejection (FDR) can be calculated by computer to be approximately 70 dB. Therefore, the required path loss to achieve compatibility is found by using the path loss equation $L_p = P_T + G_T + G_R - FDR - R_S - L_I$, and the distance separation (D) required to achieve this path loss (L_p) is found by using the equation for Basic Free Space Loss (L_{BFS});

$$L_{BFS} = L_p = 20 \log D + 20 \log f + K,$$

where:

L_{BFS} = Propagation path loss due to basic free-space attenuation (dB)

D = Distance (nmi)

f = Frequency (MHz)

K = Constant = 38

FDR = Frequency dependent rejection (OFR + OTR)

R_S = Receiver sensitivity.

TABLE 3

TECHNICAL CHARACTERISTICS OF AIRBORNE EQUIPMENTS

Characteristics	Bomb/Attack/Fire Control Radars[a]	Terrain-Following Radars[a]	Beacon Transponders[a]	Weather Radar (AN/APS-113)
Peak Transmitter Power (kW)	60	60	2	10
Minimum Pulse Width (μs)	0.4	0.2	0.75	1.5
Emission Spectrum (MHz)				
-3 dB	±1.25	±2.5	±.67	±.300
-20 dB	±8	±16	±4.2	±.840
-80 dB	±250	±500	±130	±13.50
Receiver Sensitivity (dBm)[b]	-100	-92	-66	-100
Receiver Selectivity (MHz)				
-3 dB	±2.5	±4	±40	±.650
-20 dB	±5.0	±10	±65	±2.100
-60 dB	±12.5	±22.5	±72.5	±4.750
Antenna Gain (dBi)	30	33	8	31
Operating Frequency (GHz)	16.0-17.0	16.5	16.5 Tx 16.28 Rx	15.4-15.6

[a]Nominal characteristics given.

[b]Minimum discernible signal.

As in the prior analysis, it has been assumed that for airborne systems interacting with ASDE-3 mainbeam-to-mainbeam conditions will seldom exist, and that any interference received by ASDE-3 will come from the sidelobes of the airborne transmitter antenna at a level of 0 dBi. Since the ASDE-3 antenna mainbeam will normally be pointed at a 1° depression angle (with respect to the horizon), the maximum ASDE-3 mainbeam antenna gain should never be directly coupled into the aircraft antenna of concern which are more than 3 nmi away from ASDE-3. However, in all related calculations, ASDE-3 mainbeam gain was used as a worst-case condition.

INTERFERENCE TO ASDE-3

Ground-Based Systems

TABLE 4 is a listing of the interference power levels and the associated off-tuning (Δf) needed to obtain the OFR required for compatible operation with the radar systems analyzed. The following paragraphs summarize these results.

AN/PPS-5 (Hawaii). The ASDE-3 would require a Δf of 43 MHz to operate compatibly. This separation is achievable if ASDE-3 operation is restricted to subband 1. However, since the AN/PPS-5 is tunable to 16.5 GHz, ASDE-3 operation in the full band is feasible if appropriate frequency management techniques are utilized.

SAD (Barbers Point). The ASDE-3 system would require a Δf of 119 MHz, which can be achieved with ASDE-3 operating in the entire band. Similar conclusions apply for the SAD located at Hickam AFB.

108K and 322K VEGA (Nellis AFB, Nevada). The ASDE-3 receiver would be required to be off-tuned from these systems by at least 45 MHz to achieve compatible operation. This separation can be achieved with ASDE-3 operation in full band. The increase in required frequency separation as compared to the prior analysis is due to the results of more detailed ASDE-3 selectivity data.

TABLE 4

SEPARATION REQUIRED TO AVOID GROUND-BASED INTERFERENCE TO ASDE-3

System Nomenclature	Frequency Range (MHz)	Location (State)	L_p[a] (dB)	Revised			Original		
					Required			Required	
				P_i (dBm)	OFR (MHz)	Δf (MHz)	P_i (dBm)	OFR (dB)	Δf (MHz)
AN/PPS-5	16.0-16.5	Hawaii (Statewide)	151	-51	26	43	-45	33	44
SAD	16.3	Barbers Pt. Hawaii	135	-20	57	119	-13	65	158
SAD	16.3	Hickam AFB Hawaii	137	-22	55	107	-15	63	141
108K (VEGA)	15.725	Nellis AFB Nevada	150	-49	28	45	-43	35	35
322K (VEGA)	15.725	Nellis AFB Nevada	150	-49	28	45	-43	35	35
AN/MPQ-4	16.0	Oregon	127	-10	67	322	-4	74	600

[a]See Reference 1.

AN/MPQ-4 (Oregon). The ASDE-3 receiver would be required to be off-tuned by 322 MHz. This cannot be accomplished by utilizing either ASDE-3 subband operation.

Airborne Systems

TABLE 5 summarizes the required path losses and corresponding separation distances needed to accomplish electromagnetic compatibility.

Terrain-Following Radar Systems. ASDE-3, operating in subband 1, would require a path loss of 118 dB, corresponding to a minimum distance separation of less than 1 nmi. Operation in subband 2, however, would require a minimum distance separation of 2 nmi. These results assume airborne system operation at 16.5 GHz. Since these systems are tunable to 17.1 GHz the 2 nmi separation required for the full band can be reduced to below 1 nmi through appropriate frequency management.

Beacon Transponder Systems. These systems transmit at 16.5 GHz. ASDE-3 operation in subband 1 would yield a frequency separation of 550 MHz. A separation distance of less than 1 nmi would be required to achieve the required path loss. ASDE-3 operation in subband 2, which would provide a frequency separation of 370 MHz, would require a path loss of 99 dB and a separation distance less than 1 nmi.

Bomb/Attack/Fire Control Systems. These systems can share subband 2 of ASDE-3. On-tune rejection in this case is only 0.3 dB, and the required path loss is 195 dB, which is equivalent to a separation distance that is beyond "line-of-sight". Subband 1 operation would exhibit the same line-of-sight situation (required path loss of 165 dB). These results assume airborne system operation at 16.0 GHz. However, since these systems are tunable to 17.0 GHz, minimum separation distances can be reduced to below 1 nmi through appropriate frequency coordination.

Weather Radar Systems (AN/APS-113). ASDE-3, operating in subband 1, would require a path loss of 117 dB, which corresponds to a distance

TABLE 5

SEPARATION REQUIRED TO AVOID AIRBORNE INTERFERENCE TO ASDE-3

System	Required Path Loss (dB)		Required Separation Distance[a] (nmi)	
	Subband 1	Subband 2	Subband 1	Subband 2
Terrain Following Radar System	118	128	<1	2
Beacon Transponder Systems	107	99	<1	<1
Bomb/Attack/ Fire Control Systems	165	195	LOS[b]	LOS[b]
Weather Radar System (AN/APS-113)	117	105	<1	<1

[a]Slant range.

[b]LOS = Compatible operation possible beyond "line-of-sight" distances.

separation of less than 1 nmi. Subband 2 operation would permit a frequency separation of 350 MHz, which yields a required path loss of 105 dB, corresponding again to distances less than 1 nmi.

INTERFERENCE FROM ASDE-3

Ground-based Systems

TABLE 6 lists the interference power levels and the associated off-tuning (Δf) that would be required to preclude interference.

AN/PPS-5 (Hawaii). The ASDE-3 off-tuning necessary to achieve compatible operation would be 105 MHz. This cannot be achieved with ASDE-3 operating in either subband or with the AN/PPS-5 operating at its minimum frequency of 16.0 GHz. However, since the AN/PPS-5 is tunable to 16.5 GHz, the necessary frequency separation can be obtained through appropriate frequency coordination.

SAD (Barbers Point). The required off-tuning of 117 MHz can be achieved with either ASDE-3 subband. This also applies to 112 MHz of separation required by the SAD system located at Hickam AFB.

108K and 322K VEGA (Nellis AFB, Nevada). If ASDE-3 is restricted to subband 2 operation, the 86 MHz frequency separation requirement can be achieved.

AN/MPQ-4 (Oregon). The required frequency separation cannot be achieved unless both ASDE-3 and the AN/MPQ-4 are restricted to certain discrete frequencies of operation, which are at least 169 MHz apart. This cannot be achieved with either ASDE-3 subband; however, time coordination between both systems can permit compatible operation. Also, single-frequency operation of ASDE-3 on channels 1, 2, or 3 is possible without interfering with the AN/MPQ-4.

TABLE 6

SEPARATION REQUIRED TO AVOID GROUND-BASED INTERFERENCE FROM ASDE-3

System Nomenclature	Frequency Range (MHz)	Location (State)	L_p[a] (dB)	Revised			Original		
				P_i (dBm)	Required OFR (dB)	Required Δf (MHz)	P_i (dBm)	Required OFR (dB)	Required Δf (MHz)
AN/PPS-5	16.0-16.5	Hawaii (Statewide)	151	-56	39	105	-42	53	500
SAD	16.3	Barbers Pt. Hawaii	135	-46	45	117	-34	57	560
SAD	16.3	Hickam AFB Hawaii	137	-48	43	112	-36	55	450
108K (VEGA)	15.725	Nellis AFB Nevada	150	-42	23	86	-29	36	200
322K (VEGA)	15.725	Nellis AFB Nevada	150	-42	23	86	-29	36	200
AN/MPQ-4	16.0	Portland Oregon	127	-31	65	169	-18	78	1700

[a]See Reference 1.

Airborne Systems

TABLE 7 summarizes the results for interference from ASDE-3 to airborne receivers.

Terrain Following Radar Systems. ASDE-3 operation in subband 1 would require a path loss of 81 dB, which could be obtained by maintaining a distance separation less than 1 nmi. ASDE-3 operation in subband 2 would require a path loss of 104 dB, which can again be achieved at a distance separation of less than 1 nmi; hence, the use of full band operation is acceptable.

Beacon Transponder Systems. Beacon transponders will reply only to pulses having a pulse width in the range of from 1.3 to 2.7 μs; since the ASDE-3 pulse width will be approximately 0.04 μs, no interference will occur (see Reference 1).

TABLE 7

SEPARATION REQUIRED TO AVOID AIRBORNE INTERFERENCE FROM ASDE 3

System	Required Path Loss (dB)		Required Separation Distance (nmi)	
	Subband 1	Subband 2	Subband 1	Subband 2
Terrain Following Radar System	81	104	<1	<1
Bomb/Attack/Fire Control Systems	178	196	LOS[a]	LOS[a]
Weather Radar System (AN/APS-113)	120	98	<1	<1

[a]Beyond line-of-sight.

Bomb/Attack/Fire Control Systems. ASDE-3 operation in subband 1 would permit a frequency separation of 50 MHz, requiring a path loss of 178 dB. This results in a distance separation beyond line-of-sight. ASDE-3 operation in subband 2 would result in an on-tune condition, again resulting in a beyond line-of-sight distance separation requirement. However, an additional study has detailed the effects of operational control on these separation requirements.[2] Frequency management and time coordination can permit compatible operation.

Weather Radar System (AN/APS-113). ASDE-3 operation in subband 1 would require a path loss of 120 dB, achievable at a distance separation of less than 1 nmi. ASDE-3 operation in subband 2 would require a path loss of 98 dB, which also corresponds to a distance separation of less than 1 nmi.

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[2]Ellis, M. and Klimczak, The Effect of ASDE-3 Operation on AN/APQ-113, AN/APQ- 92, AN/APQ-148, AN/ASB-12, AN/ASG-21 Airborne Radars (U), FAA-RD-78-141, ECAC, Annapolis, MD, February 1978, (CONFIDENTIAL) (Review February 1998).

SECTION 3
SUMMARY AND CONCLUSIONS

SUMMARY

The following results have been determined regarding electromagnetic compatibility of the associated systems with the frequency-agile ASDE-3 radar system.

Ground-based Systems

AN/PPS-5 (Hawaii). Compatible operation with the ASDE-3 radar is possible if the ASDE-3 is restricted to operation in Subband 1. ASDE-3 Subband 2 can also be used if the AN/PPS-5 is restricted to frequencies above 16.175 GHz.

SAD (Both Locations). These systems may operate compatibly with ASDE-3 regardless of ASDE-3 subband operation.

108K and 322K VEGA (Nellis AFB, Nevada). The 108K and 322K VEGA will not interfere with ASDE-3 operation regardless of ASDE-3 subband usage. Restricting ASDE-3 operation to subband 2 will ensure that ASDE-3 transmissions will not interfere with these systems.

AN/MPQ-4 (Oregon). Mutual compatibility between the ASDE-3 and AN/MPQ-4 is not predicted, regardless of ASDE-3 frequency usage. However, time coordination of both systems can permit compatible operation.

Airborne Systems

Terrain Following Radar Systems, Beacon Transponders, and Weather Radar Systems. Electromagnetic compatibility can be maintained between these systems and ASDE-3. An operational distance separation of at least 1 nmi is

recommended; however, frequency management techniques may be used to further reduce the required separation distance.

Bomb/Attack/Fire Control Systems. Compatible operation is feasible if frequency coordination is used and the Bomb/Attack/Fire Control systems are restricted to operation in the upper portion of their operational frequency band.

CONCLUSION

The results of this supplemental analysis have led to the conclusion that, of the system interactions analyzed, there will be no uncontrollable EMC concerns resulting from ASDE-3 deployments at any of the 33 proposed sites, since frequency management and time coordination between the ASDE-3 transmitter/receiver and the interacting equipments analyzed may be used if required. Of the systems analyzed, EMC is achievable between the ASDE-3 and:

1. SAD (both locations), the Terrain Following Radar, Beacon Transponder, or Weather Radar systems without any operational restrictions.
2. 108K Vega (Nellis AFB), 322K Vega (Nellis AFB), AN/PPS-5 (Hawaii), or Bomb/Attack/Fire Control Radar systems with proper frequency or time coordination.
3. AN/MPQ-4 (Oregon) system only through time coordination.

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